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Preliminary Assessment
Big River Mine Tailings
Desloge, St. Francois County, Missouri
TDD #F-07-8711-039 PAN #FM00616PA
Site #Y60 Project #001
Submitted to: Paul E. Doherty, RPO
Task Leader: Robert Overfelt, E & E/FIT
Superfund Contact: Gene Gunn
Date: May 17, 1988

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SECTION 1: INTRODUCTION

The Ecology and Environment, Inc., Field Investigation Team (E & E/FIT) was tasked by the U.S. Environmental Protection Agency (EPA) to conduct a Preliminary Assessment (PA) of the Big River Mine Tailings site near Desloge, Missouri. The tasks authorized under Technical Directive Document (TDD) #F-07-8711-039 were to gather and review background information, conduct a site reconnaissance, prepare a preliminary assessment report, and submit an updated EPA Preliminary Assessment Form 2070-12.

A site reconnaissance was conducted by E & E/FIT member Robert Overfelt on January 25, 1988. Site conditions were documented with photographs (Appendix D).

The site was brought to the attention of the Region VII EPA because mine tailings containing lead and other heavy metals were entering the Big River due to erosion. A high potential for heavy metals contamination of the Big River exists at this site.

SECTION 2: SITE DESCRIPTION AND HISTORY

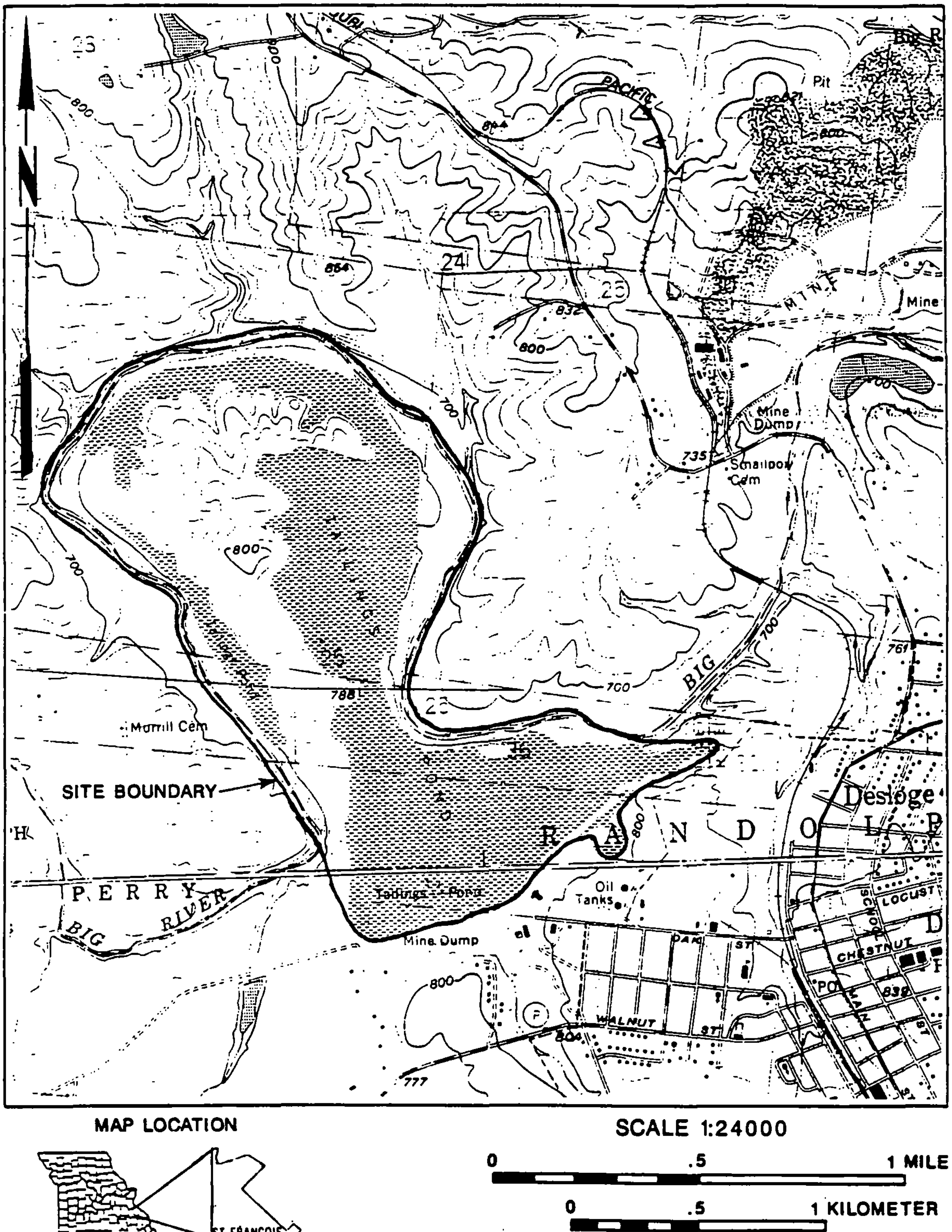
2.1 SITE DESCRIPTION

The Big River Mine Tailings site is located in St. Francois County approximately one-half mile northwest of Desloge, Missouri (Figure 1). This area of southeast Missouri is known as the "Old Lead Belt" and was formerly a major producer of lead. The coordinates of the approximate center of the site are 37° 53′ 11".4 north latitude and 90° 33′ 00".0 west longitude (Ref. 1).

The Big River Mine Tailings site covers approximately 600 acres (Figure 2). It consists mainly of mine tailings ranging from 0 to 100 feet deep (Ref. 2). A sanitary landfill and landfill office are located on the south end of the site. The landfill is operated by the St. Francois County Environmental Corporation which has a state permit to fill approximately 60 acres (Ref. 3). There are six monitoring wells installed around the landfill and the well logs are included as Appendix B. The majority of the site is situated within a horseshoe meander of the Big River (Figure 2).

2.2 SITE HISTORY

The 600-acre Big River Mine Tailings site is the result of 30 years (1929 to 1958) of stockpiling lead mining wastes from a mill which was located just west of the Desloge City limits (Ref. 4). After processing, the tailings were transported to the site via a slurry pipeline. Tailings ponds were formed when the tailings settled out. The St. Joe Minerals Corporation owned the tailings site until 1972 when it donated the majority of the site, 502 acres, to St. Francois County (Ref. 4). Approximately 100 acres, which is located directly east of the present-day landfill, is still owned by St. Joe Minerals. An immense mine tailings pile, estimated between 75 and 125 feet high, is located on the St. Joe Minerals property (Ref. 3) (Figure 3).

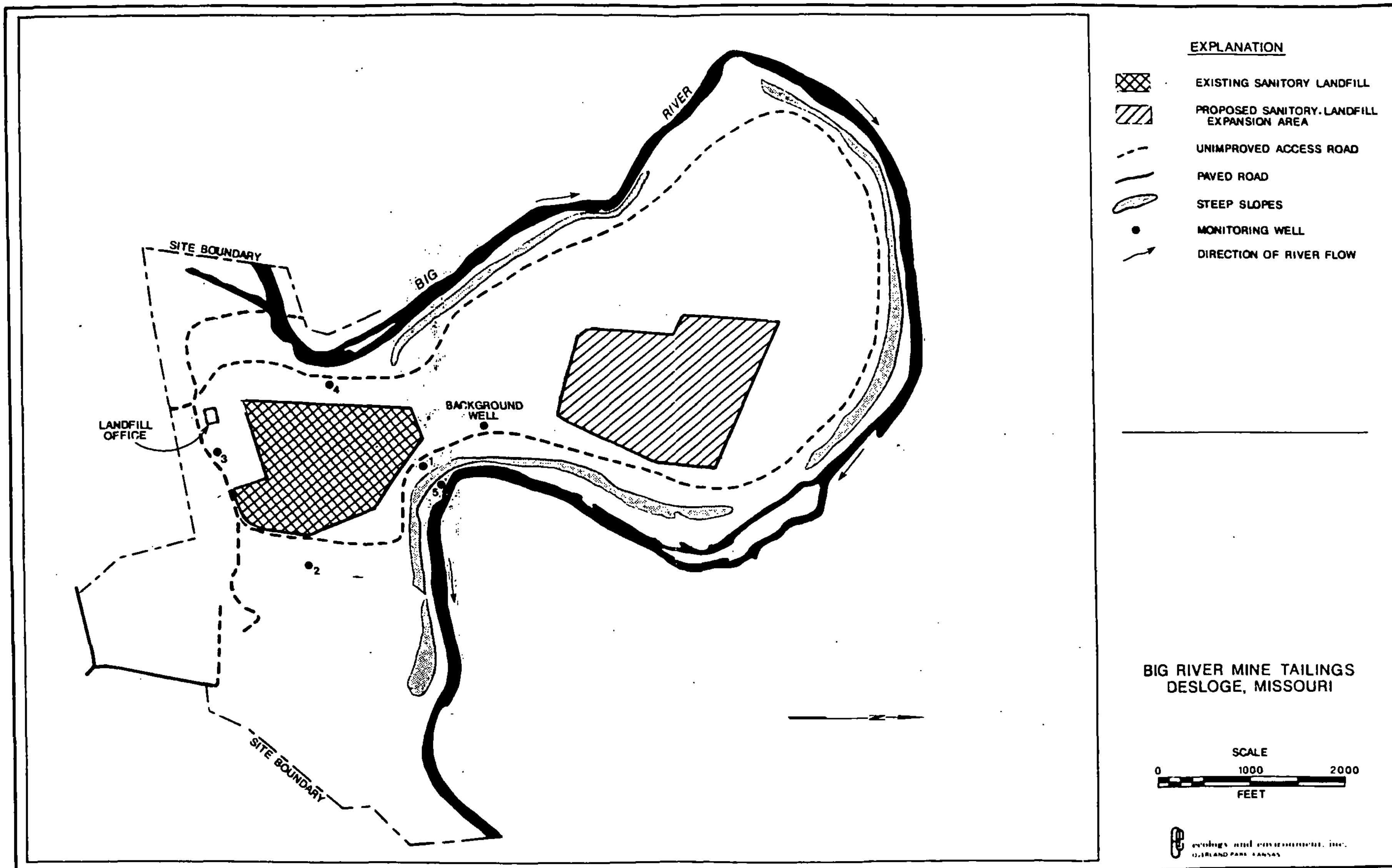


BIG RIVER MINE TAILINGS
DESLOGE, MISSOURI

WASTE SITE TRACKING #: MO0616
PREPARED BY: R. OVERFELT

ECOLOGY & ENVIRONMENT FIT MARCH 1988
SOURCE: USGS 7.5' BONNE TERRE & FLAT RIVER, MO QUADS. 1982

FIGURE 1-1: SITE LOCATION



WASTE SITE TRACKING NO.: MO0616
PREPARED BY: C. WILLIAMS

FIT APRIL 1988
SOURCE: REF. 10

FIGURE 2: SITE MAP

After acquisition of the 502 acres, St. Francois County leased the land to the St. Francois County Environmental Corporation (SFCEC) (Ref. 5). In 1973 the non-profit SFCEC established a sanitary landfill on approximately 60 acres of the southwest section of the mine tailings pile (Ref. 2 and 3). Bryant AuBuchon, manager of the SFCEC landfill, stated that the landfill excepts typical residential refuse and debris and that the refuse is not separated into specified cells (Ref. 5). Hudwalker and Associates, Inc., a consulting engineering firm located in Farmington, Missouri, has administered landfill operations and maintenance of the tailings pile for the last three years (Ref. 3).

Marvin Hudwalker of Hudwalker and Associates, Inc., was present during the reconnaissance. He stated that mine tailings were used as daily cover on the trash and that when a cell is filled a one-yard thick clay cover is applied and grass is planted. During the reconnaissance, the filled landfill cells were noted to have a continuous cover and the area was relatively clean.

A review of the Missouri Department of Natural Resources (MDNR) files regarding the landfill revealed that the landfill operation was very inadequate before Hudwalker and Associates took over administration. The facility was cited numberous times for various violations. Photographs from repeated inspections of the landfill depict large amounts of refuse with no cap or vegetated cover (Ref. 9).

According to a 1977 University of Missouri-Columbia report, the area experienced a severe storm event involving the section of the tailings pile known as Gap "A" which is located adjacent to the Big River on the southeast side of the horse-shoe bend (Figure 3). This portion of the mine tailings pile became supersaturated and collasped, releasing its contents into the Big River (Appendix D, Photo C-3). Although the exact quantity of mine tailings that washed into the river is not known, estimates suggest that the quantity may have been as much as 50,000 cubic yards (Ref. 3) (Figure 3). When the MDNR discovered this catastrophic event, they requested that the Environmental Protection Agency Surveillance and Analysis team (SVAN) conduct an extensive investigation of the Big River. The SVAN conducted this survey in late 1977, and the general findings, based on aquatic population density and diversity, were that the Big River was degraded by the mine tailings that entered the river. The degradation was mainly the result of physical changes in the benthic zone of the river rather than chemical toxicity of the river water (Ref. 2).

In 1980 the Missouri Department of Conservation submitted evidence that some fish sampled downstream from the tailings pile contained elevated levels of lead (Ref. 2). This report concluded that the high concentrations of lead were found in the edible tissue of fish found in the Big River downstream from the location where mine tailings had entered the river during the rupture in 1977. The highest concentration found, 1.30 ppm, was found in sample nine from four golden redhorse fish collected immediately downstream from the collasped Desloge tailings pile (Ref. 6). The World Health Organizations (WHO) dietary limit for lead is 0.3 ppm (Ref. 6).

As a result of these findings, the state of Missouri issued a press release cautioning local residents not to eat bottom-feeders taken from a 50-mile stretch of the Big River from the city of Leadwood (near the Desloge tailings pile) downstream to Washington State Park (Ref. 7). Since 1980 numerous research projects have focused on the impact of the mine tailings piles in the Old Lead Belt on the Big River. Results of various studies of the mine tailings and their effect on the Big River will be presented in Section 3.

By December 1981 St. Joe Minerals Corporation, under a cooperative agreement with the state of Missouri, began remedial action on the pile in an effort to fill the erosional gaps and stabilize the pile (Ref. 8). Many smaller erosional events have been documented since the massive release in 1977. Section 2.3 will detail the past and present erosional problems as well as the efforts undertaken to stabilize the piles.

In the spring of 1985 the Desloge Tailings Task Force was organized to deal with the existing problems of the Desloge Mine Tailings site. The Task Force, organized by St. Joe Minerals, consisted of representatives from St. Joe Minerals, the landfill, and MDNR, as well as local officials and others. Specific activities of the Task Force are detailed in Section 2.3. The Task Force focused on three primary objectives:

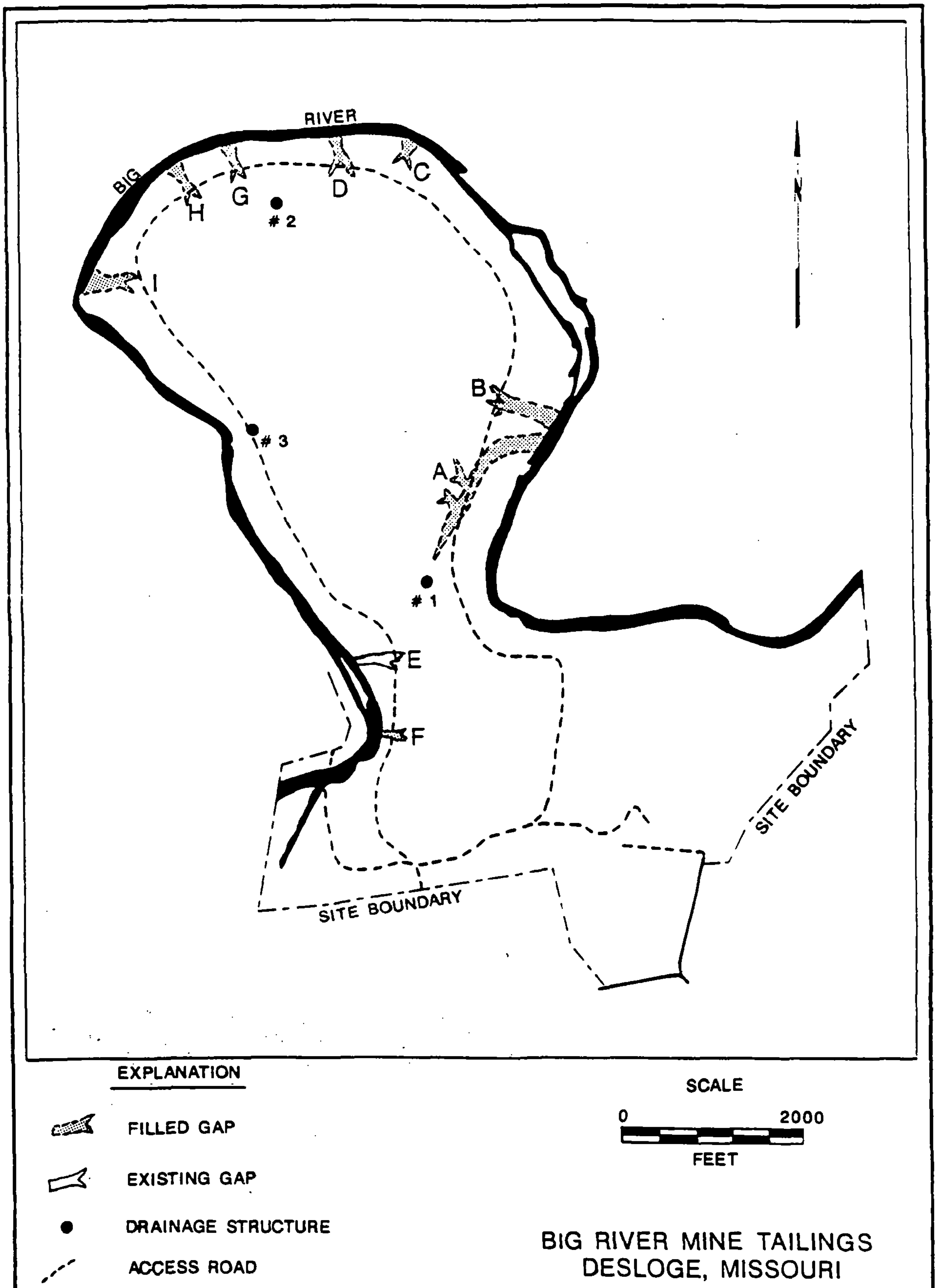
1. Provide adequate site supervision to ensure proper repair and maintenance.
2. Develop and implement short-term measures to stabilize the site.
3. Develop a long-term stabilization plan for the site.

Landfill authorities requested a permit from the state of Missouri to expand operation into 200 additional acres of the tailings pile. In January 1987, as a result of this proposed expansion, the MDNR requested that six monitoring wells be installed around the existing landfill to determine whether the ground water contained significant quantities of landfill leachate (Ref. 3) (Figure 2). The well logs for these six monitoring wells are included as Appendix B. Water samples have been taken from the wells but the results of the analyses have not been received.

2.3 STABILIZATION EFFORTS

After the massive release of mine tailings into the Big River in 1977, efforts to stabilize this mine tailings pile were initiated. A number of remedial efforts have been accomplished. The reports from several agencies detail the problems that exist at the site and presnet solutions to these problems.

A comprehensive report prepared in 1980 for MDNR by the University of Missouri Columbia (UMC) College of Engineering characterizes the major environmental concerns at the site including water and wind erosion and the apparent hazard of constructing a landfill in the tailings pile. The UMC investigation concluded that the tailings pile contained numerous points where tailings are entering the Big River due to water erosion. The UMC team designated six gaps, which were labeled alphabetically around the pile starting on the southeast side (Figure 3). Erosional gaps G, H, and I developed after the report was completed and have been labeled as they occurred.



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SOURCE: REFERENCE 4

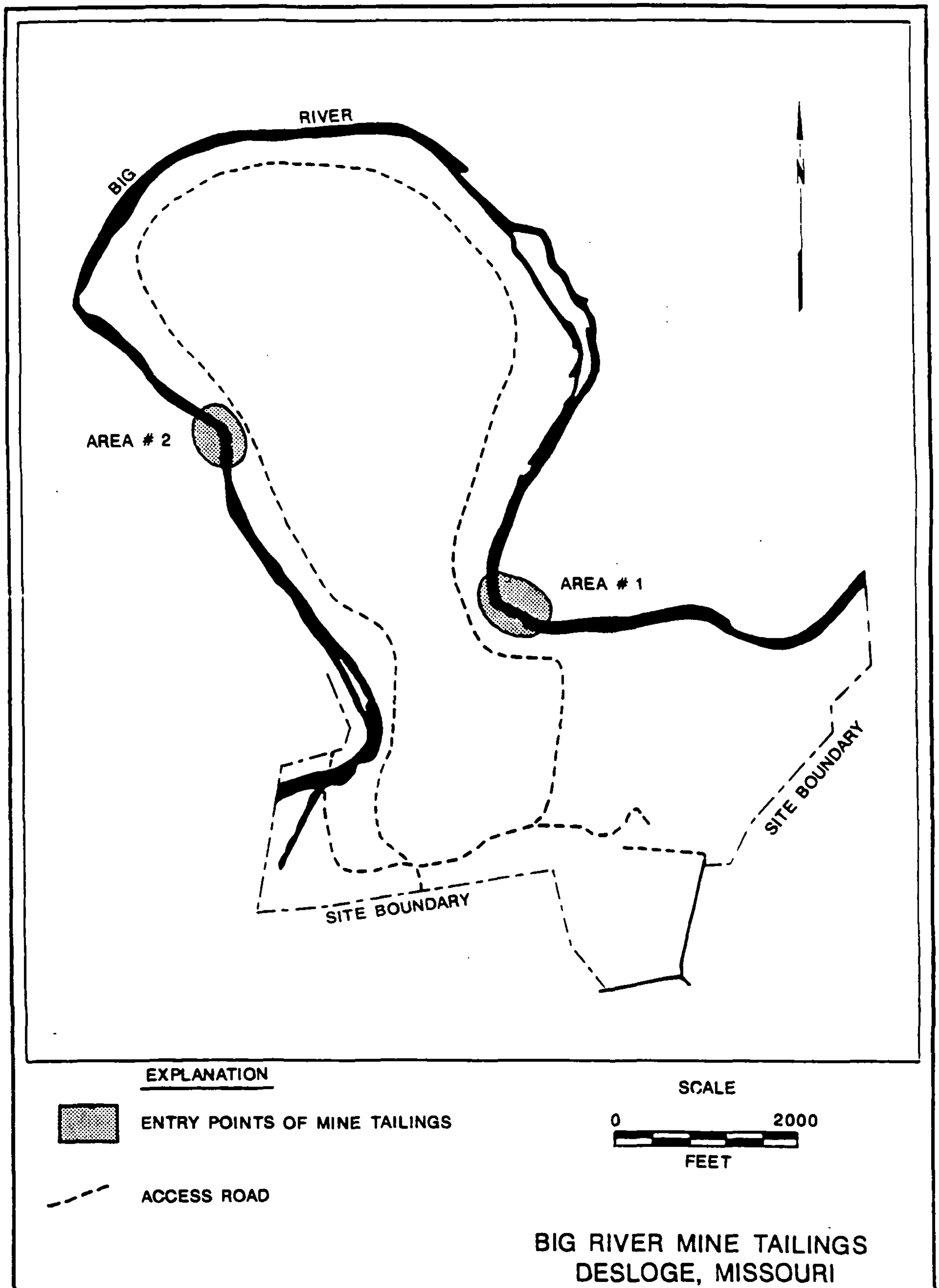
FIGURE 3: MAJOR EROSIONAL FEATURES

The original drainage structures placed by the mining company are illustrated in Photo C-14 (Appendix D). These concrete drainage structures were constructed to drain the water from off the tailings pile. During the E & E/FIT site reconnaissance, it was noted that drainage structure #1 near Gap A was totally collapsed and was no longer functional. According to the UMC report, drainage structure #1 became blocked and this blockage led to the massive erosion which occurred in 1977 at Gaps A and B. The UMC report recommended that the major erosional gaps be filled with a suitable fill material and the area reshaped to reduce further erosion. Further, the report suggested that the drainage structure located near Gap A be altered to minimize the chance for overflow (Ref. 4).

Wind erosion and the associated blowing of lead-laden dust is also a major concern (Appendix D, Photo C-1). There the tailings pile reaches the river bank in two area (Figure 4). During the FIT reconnaissance, it was noted areas #1 and #2 that the wind was eroding the tailings over the steep incline. As tailings accumulate, and their angle of repose is exceeded, they collaspe and fall into the river (Photo C-2). The major problem at area #2 is the river undercutting the bank, which eventually could lead to a collaspe of the tailings in the area into the river (Photos C-12, C-13). Wind erosion is generally from west to east, which produces a continuous movement of the tailings toward the east. Because the tailing are a very fine, dolomitic sand or silt sufficient wind velocity creates a tailings dust cloud. During the site reconnaissance this occurrence was observed to be a serious problem (Photo C-1). A dust plume originating from the site was transporting dust at least one mile to the southeast. Wind speeds on that day included gusts up to 35 miles per hour.

The UMC report recommended that a study be undertaken to assess the possibility for plant growth to be established on the pile to control wind erosion. Plant life is very difficult to establish in this environment for several reasons:

- A serious nutrient deficiency exists in the tailings;
- Wind erosion prevents establishment of seedlings;
- Moisture cannot be retained, especially on the slopes, due to the porous nature of the tailings; and
- The lead content of the tailings may cause plant sterilization, preventing reseeding by existing plants.



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SOURCE: REFERENCE 4

FIGURE 4: OBSERVED ENTRY POINTS OF MINE TAILINGS TO BIG RIVER

Because of these deleterious conditions, natural plant growth on the pile is almost non-existent. This experimentation was suggested as an attempt to establish a method for maintaining a vegetative cover.

The UMC report considers the landfill on site to be a serious potential problem. The liquid runoff (leachate) that results from a landfill is typically low pH and contains large quantities of organic material. If these conditions exist it is very possible that heavy metals could be leached from the tailings and transported to the Big River. In the UMC report, tests were conducted by extracting mine tailings with nitric acid, distilled water, and ethylenediaminetetra-acetic acid (EDTA). The nitric acid extraction represents total quantity of metals in the tailings. The distilled water extraction represents what is released by the movement of rain water through the tailings. The EDTA extraction represents the potential for extraction by landfill leachate (Table 1). Metals that are extracted by landfill leachate would also be chemically bound by organics and might remain in solution after entering a body of water such as the Big River. During the reconnaissance the area where landfilling was complete and soil cover was applied was observed to be much more stable than the adjacent mines tailings. However, the benefits of soil cover are offset by the potential for landfill leachate to release lead and other metals from the tailings (Ref. 4).

These three problems of water erosion, wind erosion, and the landfill are considered the primary concerns at the Desologe tailings pile. When the UMC report was submitted in 1980, no remedial action had begun. However, St. Joe Minerals Corporation began remedial activities in 1981 that are continuing.

In December 1981 St. Joe Minerals Corporation began filling Gaps A, B, C, and D. This remedial action was completed in January 1982 (Ref. 8). C. G Mattson, Project Manager, St. Joe Minerals Corporation, provided a summary of the remedial activity and maintenance performed since the initial work on Gaps A, B, C and D.

Inspections have been performed at least once per month from December 1981 to the present by St. Joe Minerals and/or the engineer for the landfill. Inspections also are made after or during heavy rainfall

Table 1
Metal Analyses of Tailings
Big River Mine Tailings Desloge, Missouri
University of Missouri-Columbia College of Engineering

	Clay (ug/g dry)			Sand (ug/g dry)		
Metal	Water	EDTA	HNO_3	Water	EDTA	HNO_3
Lead	20	2,200	2,400	26	720	850
Cadmium	N.D.	3.2	14	N.D.	5.8	25
Zinc	3.4	220	680	14	230	1,000

NOTE: N.D. is not detected.
Water: Represents rainfall through tailings.
EDTA: Ethylenediaminetetraacetic acid and represents landfill leachate through tailings.
HNO_3: Represents total metal content in tailings.

Source: Ref. 4

events. The inspections consist of confirming that all drainage structures are functional and that no observable defects have occurred in the retaining berm.

In April 1983 two small gaps, designated Gaps G and H were formed when unusually heavy rainfall overtopped the retaining berm (Photo C-8). The gaps were filled and a 22-inch steel pipe drainage structure was placed in each. In October 1984, 1,500 feet of fence was placed along the base of the chat pile and the area north of the fence was seeded, fertilized, and covered with straw mulch. This fence was built to reinforce a dune formed by a wind fence placed in 1980.

In April 1985 Gap "I" was formed when heavy rainfall topped the retaining berm. The gap was filled and a 22-inch steep pipe drainage structure was established. At the same time, 2,000 feet of snow fence was placed in the area of the break to build up the retaining berm with wind-blown material. The open channel spillway cut that drains the pond area was deepened and a diversion ditch was cut across natural ground to keep water from flowing into the Gap "I" area (Photo C-10 and C-11). A diversion dike was built through natural ground so that water diverted by the landfill operations would not flow into Gap "E" (Photos C-15, C-16 and C-17).

In October 1985, the approximately 20 acres of tailings that comprose the major portion of the Gap "I" drainage area were fertilized and seeded. During the FIT reconnaissance it was apparent that the vegetation in this particular area was growing well and had stabilized the area. It should be noted that this area is flat and stable relative to other steep sloping, dune-like areas that also exist on the tailings pile (Photo C-9).

In March 1986, 10,000 Black Locust trees were planted on the Desloge tailings area, some 7,500 of them were planted in the Gap "I" drainage area that was sown in October 1985. During the reconnaissance it was apparent that the seeding of Black Locust in this area was very successful. Some trees were approximately 12 feet tall (Photo C-9). In February 1987, 15,000 Black Locust trees were planted on the approximately 15 acres of tailings that form the drainage area for Gap "G" (Photos C-6 and C-7).

The latest activity was in September and October 1987 when some 20,000 feet of wind fencing was installed on the upper portion of the tailings area. During the FIT reconnaissance it was noted that much of this fencing was damaged or blown down due to a recent storm. Reconstruction of the fencing, as well as reinforcement, are planned. It was obvious that the wind fencing was controlling some movement of the sand-like material, but it is ineffective during stronger winds (Photos C-4 and C-5) (Ref. 8).

In 1985 the Desloge Tailings Task Force contracted the engineering firm Burns and McDonnel, Inc., to develop a long-term stabilization plan. The investigation and report was funded 25 percent by the

Table 2
Site History and Stabilization Efforts

Date	Chronology of Pertinent Site Events
1929-1958	Mining occurred and tailings were deposited in slurry form.
1973	St. Joe Minerals Corporation donated 502 acres to St. Francois County. St. Francois County leased the land to the St. Francois County Environmental Corporation which opened the existing landfill.
1977	Collaspe of tailings in Gaps A and B; SVAN reports degradation of Big River due to influx of tailings during collaspe.
1980	Missouri Department of Conservation determined elevated Pb levels in bottom-feeding fish and issued a press release cautioning local residents not to eat these fish.
1981	St. Joe Minerals began remedial activity in an attempt to stabilize the tailings.
1983	Gaps "G" and "H" were formed by overtopping of the retaining berm.
1984	1,500 feet of wind fencing installed.
1985	Desloge Tailings Task Force was organized Gaps "I" was formed by overtopping Burns & McDonnel long term stabilization plan 20 acres near Gap "I" were seeded, and appear to be growing well.
1986	10,000 Black Locust trees planted near Gap "I".
1987	Monitoring wells installed around landfill. Some 15,000 Black Locust trees planted near Gap "G". 20,000 feet of wind fencing installed.

landfill corporation and 75 percent by St. Joe Minerals. The Burns and McDonnel proposal was highly criticized because it included creating several ponds on the tailings pile to control surface runoff (Ref. 10). Because of the proven instability of the tailings, the plan to create ponds on the pile was not considered a satisfactory solution. The chronology of the significant stabilization efforts is summarized in Table 2.

In April 1987 the Soil Conservation Service proposed some stabilization plans for the site to the Desloge Mine Tailings Task Force. They suggested diverting the surface drainage away from critical erosion areas and planting some test plots to determine what methods might be best for revegetation (Ref. 11). Current plans are to carry out revegetation test plot experiments in an attempt to determine what plants and planting methods are best suited to the mine tailings.

2.4 SITE CONTACTS BIG RIVER MINE TAILINGS

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SECTION 3: WASTE CHARACTERISTICS

It has been determined that the mine tailings located at the Big River Desloge Tailings pile contain significant amounts of lead, cadmium and zinc (Ref. 10). The tailings from the pile are migrating into the river and ambient air via water and wind erosion. Therefore, it is possible that these heavy metals constituents may be contaminating the river and the air. This section will discuss the three heavy metals of concern (lead, cadmium, and zinc) their characteristics, potential hazards, and relevant EPA Maximum Contaminant Levels (MCL).

Lead exists in nature mainly as lead sulfide (galena). Other common forms are lead carbonate (cercissite), lead sulfate (anglestie) and lead chlorophosphates (pyromorphite). Stable complexes result from the interaction of lead with the sulflydryl, carboxyl, and amine coordination site found in living matter. The toxicity of lead in water is affected by pH, hardness, organic materials, and the presence of other metals. The aqueous solubility of lead ranges from 500 ug/l in soft water to 3 ug/l in hard water (Ref. 13).

Lead is a toxic metal that tends to accumulate in the tissues of humans and other animals. Although seldom seen in the adult population, irreversible damage to the brain is a frequent result of lead intoxication in children. This most commonly results from ingestion of lead-containing paint found in older homes. The major toxic effects of lead include anemia, neurological dysfunction, and renal impairment. The most common symptoms of lead poisoning, which usually develop slowly, are anemia, severe intestinal cramps, paralysis of nerves (especially the arms and legs), loss of appetite, and fatigue. The Maximum Contaminant Level (MCL) established for lead in drinking water is 50 ug/l (Ref. 14). The National Ambient Air Quality Primary Standard for lead in the air in a calendar quarter is 1.5 ug/m^3 (Ref. 15).

Cadmium occurs mainly as a sulfide salt, frequently in association with zinc and lead ores (Ref. 13). Accumulation of cadmium in soils in the vicinity of mines and smelters may result in high local concentrations in nearby waters. Cadmium is deposited and accumulated in various body tissues. Cadmium may function in or may be an etiological factor for various human pathological processes including testicular tumors, renal dysfunctions, hypertension, arteriosclerosis, growth inhibition, chronic diseases of old age, and cancer (Ref. 13). The MCL established for cadmium in drinking water is 10 ug/l (Ref. 14).

Zinc is usually found naturally as a sulfide and if is often associated with other metals, especially lead, copper, cadmium and iron. It is used in galvanizing processes and in preparation of alloys. Zinc is essential and beneficial in human metabolism. Community water supplies tested have contained 11 to 27 mg/l without harmful effects. The toxicity of zinc compounds to aquatic animals is modified by environmental factors. An increase in temperature and reduction in dissolved oxygen increases the toxicity of zinc for fish. Toxic concentrations of zinc compounds cause adverse changes in the morphology and physiology of fish (Ref. 13). The final secondary MCL established for zinc is 5,000 ug/l (Ref. 14). No primary MCL for zinc has been established.

In a study prepared by the University of Missouri Rolla, the Desloge tailings pile was sampled extensively (77 samples were taken) for its lead, cadmium, and zinc content. Values for lead range from 826 to 6,200 ug/g with a mean of 2077 ug/g; cadmium ranged from 6.8 to 78.6 with a mean of 26 ug/g. Zinc ranged from 233 to 3,990 ug/g with a mean of 1,226 ug/g. See Appendix D for complete sample results (Ref. 12).

SECTION 4: PAST INVESTIGATIONS

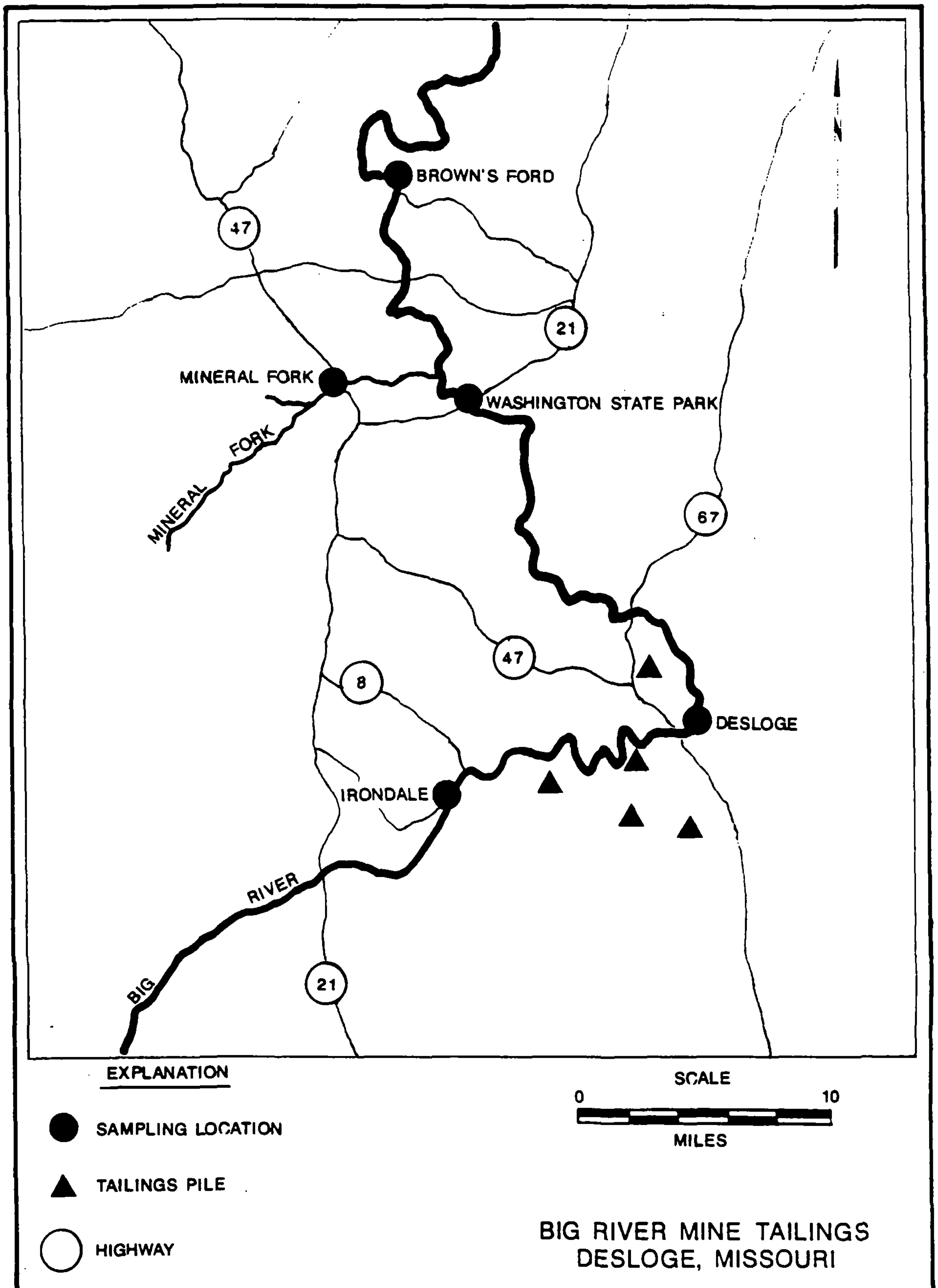
Numerous investigations regarding the effects of mine tailings on the Big River have been completed since the massive erosional event in 1977. This section will address the significant results of this research.

4.1 METALS IN BIG RIVER WATER AND SEDIMENT

In a report submitted by the National Fisheries Research Laboratory the metals content in river water and sediment was measured at different locations along the Big River (Figure 5). The Irondale and Mineral Fork sample locations were considered control areas while Desloge, Washington State Park, and Brown's Ford sites are 5 miles, 37 miles and 60 miles, respectively downstream from the Desloge Mine Tailings pile.

Water sampling was done during low, medium, and high flow. Total metals and dissolved metals were measured for lead (Pb), cadmium (Cd) and zinc (Zn). The highest total Pb (0.68 mg/l) was found at Washington State Park and the highest dissolved Pb (0.026) occurred at Brown's Ford (Table 3). The dissolved Pb concentrations were all below the 0.05 mg/l MCL for Pb. Cd and Zn concentrations were all within established MCLs for these compounds.

Sediment samples were collected from corresponding locations on the Big River. Total sediment Pb concentrations were highest at Desloge (2215.0 ug/g) and tended to decrease with distance downstream. This value is similar to the Pb content found in the tailings at the Desloge pile (Appendix D). Total Pb concentration was lowest (49.6 ug/g) at Irondale. Concentration at Mineral Fork were substantially higher than at Irondale, though were lower here than at other locations. This is probably attributable to the past Pb mining or on-going barite mining activities in the Mineral Fork watershed. These sampling results show how the mine tailings had affected the benthic zone of the Big River at the Desloge mining pile and for several miles downstream (Table 3) (Ref. 16).



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SOURCE: REFERENCE 16

FIGURE 5: SAMPLE LOCATIONS ON BIG RIVER

Table 3
Metals Concentrations in Water Samples Collected in the Big River
Big River Mine Tailings, Desloge, Missouri

Location Stage	Flow (CFS)	Pb D	Pb T	Cd D	Cd T	Zn D	Zn T
Mineral Fork							
Low	29.6	0.005	0.009	0.001	0.001	<0.01	<0.01
Med.	160.0	0.006	0.005	0.001	0.001	<0.01	<0.01
High	505.0	0.005	0.009	0.001	0.001	<0.01	<0.01
Brown's Ford							
Low	95.6	0.005	0.043	0.001	0.001	0.02	0.03
Med.	650.0	0.007	0.084	0.001	0.001	0.01	0.03
High	11900.0	0.026	0.440	0.001	0.001	0.05	0.17
Washington State Park							
Low	70.2	0.009	0.091	<0.001	<0.001	0.01	0.04
Med.	490.0	<0.005	0.140	<0.001	<0.001	0.01	0.07
High	11395.0	0.021	0.680	<0.001	<0.004	-----	0.22
Desloge							
Low	45.3	0.020	0.041	0.002	0.004	0.31	0.36
Med.	298.0	0.010	0.085	0.001	0.001	0.06	0.11
High	932.0	0.012	0.110	0.002	0.004	0.10	0.16
Irondale							
Low	7.1	0.005	0.005	0.001	0.001	<0.01	<0.01
Med.	160.0	0.005	0.005	0.001	0.001	<0.01	<0.01
High	300.0	0.005	0.005	0.001	0.001	<0.01	<0.01

Reporting unit is mg/l.

NOTE: CFS = Cubic feet per second.
D = Dissolved Metals; T = Total Metals.

Source: National Fisheries Research Laboratory Report (Ref. 16).

Table 4
Metals Concentrations in Sediment Samples
Collected in the Big River
Big River Mine Tailings, Desloge Missouri

Location	Pb	Cd	Zn
Irondale	49.6	1.62	64.9
Desloge	2,215.0	29.96	1658.4
Washington State Park	1,843.4	10.79	704.3
Brown's Ford	1,438.3	6.55	484.5
Mineral Fork	291.5	2.52	369.7

NOTE: Adjusted total sediment metal concentrations (ug/g dry weight).

Source: National Fisheries Research Laboratory Report (Ref. 16).

4.2 METALS IN AQUATIC BIOTA

Several past studies have focused on the elevated metal levels in the aquatic biota present in the Big River.

In the report prepared by the National Fisheries Laboratory, crayfish, fresh water mollusks, and fish also were sampled. The sample locations were the same as for surface water and sediments (Figure 5). In crayfish samples, Pb and Cd levels were elevated at Desloge, Washington State Park, and Brown's Ford. The highest Pb concentration was 140 ug/g at Desloge. Pb concentrations of crayfish were 1.4 ug/g at Irondale and 2.7 ug/g at Mineral Ford. Since crayfish feed on aquatic macrophytes and detritus they can accumulate sediment-bound toxins.

Pocketbook mussels were collected at all the locations except Desloge, where none could be found. Results showed the highest mean Pb concentrations at Brown's Ford ranging from 310 to 490 ug/g in soft tissue and 18 to 19 ug/g in the shell. Pb levels at Washington State Park were from 200 to 310 ug/g in soft tissue and 8 to 22 ug/g in the shell. The control sample at Irondale had mean Pb levels of 2.16 ug/g in soft tissue and 0.76 ug/g in the shell.

The results of fish samples collected on the Big River varied with fish types. Bottom-feeders, such as catfish and the Redhorse sucker, tended to have higher concentrations of metals than fish such as the smallmouth bass that do not feed on bottom sediment. The Pb content in the Redhorse sucker was greater than the 0.3 ug/g dietary limit recommended by the World Health Organization (WHO) at Desloge (0.57 ug/g), Washington State Park (0.43 ug/g), and Brown's Ford (0.63 ug/g). The Pb concentrations at Irondale and Mineral Fork were well below the WHO limit (Table 5) (Ref. 16).

Research conducted on fish over a five-year period by the University of Missouri Rolla confirms the above results. This research shows that over a five-year period, the Pb concentrations in suckers from the Big River near the lead tailings piles have consistently exceeded the WHO limit (Ref. 17).

These research results demonstrate that mine tailings have raised lead levels in the benthic zone of the Big River and in the bottom feeders that live in this zone of the river. This study also determined that the tailings have had little effect on the heavy metals content in the river water.

4.3 MINE TAILINGS FOR USE AS AGRICULTURAL LIME

Research done by the University of Missouri Rolla on the possible use of mine tailings as agricultural lime determined that this practice may be acceptable. It also states that caution should be taken because some older tailings piles have much higher concentrations of Pb than more recently developed piles. It must also be noted that plant uptake studies have indicated that both lettuce and radishes tend to accumulate some Pb and Cd when lead/zinc tailings were mixed with soil as agricultural lime (Ref. 12).

4.4 LEAD IN DUST FROM TAILINGS PILE

The Missouri Department of Natural Resources (MDNR) collected air quality data near Flat River, Missouri, approximately 2 miles southeast of the Desloge mine tailings pile. MDNR used one hi-vol monitor located approximately 2,000 feet north of the St. Joe Park Tailings Pile near

Flat River. Data was collected for the three-year period 1981, 1982, and 1983. Monitor filters taken during the initial sampling period of January through August 1981 were analyzed for Pb. No additional filters in the three-year period were analyzed for Pb. The total suspended particulate (TSP) annual geometric mean in 1981 was 50.55; 1982 was 35.47; and 1983 was 47.43 ug/m^3 (Ref. 18). The National Ambient Air Quality Standard (NAAQS) for the annual geometric mean of TSP is 75 ug/m^3 (Ref. 15). The results of the Pb analyses for the first three quarters of 1981 were January-March 0.14 ug/m^3, April-June 1.09 ug/m^3, and July-August 0.17 ug/m^3 (Ref. 18). The NAAQS primary standard for Pb in a calendar quarter is 1.5 ug/m^3 (Ref. 15). These results are all within the standards for air quality and are adequate for southerly winds. Because the prevailing winds in this part of the country vary from season to season or month to month additional hi-vol monitoring devices situated around the tailings pile would have been more effective than one unit (Ref. 19). Also, a background or control hi-vol monitor was not used, so no control data is available for comparison.

Table 5
Metals Concentrations in Edible Portions
of Fish in the Big River
Big River Mine Tailings Desloge, Missouri

Location Species	Pb	Cd	Zn
Mineral Fork			
Smallmouth bass	0.19	0.01	13.97
Yellow bullhead	0.13	0.02	5.67
Redhorse sucker	0.08	0.01	13.42
Brown's Ford			
Smallmouth bass	0.21	0.01	4.50
Flathead catfish	0.29	0.02	12.24
Redhorse sucker	0.63	0.01	11.67
Washington State Park			
Smallmouth bass	0.27	0.01	9.49
Flathead catfish (4)	12.00	0.34	23.00
Redhorse sucker	0.43	0.01	9.38
Mixed suckers	0.38	-----	-----
Desloge			
Smallmouth bass	0.05	0.01	11.73
Channel catfish	0.13	0.03	5.12
Redhorse sucker	0.57	0.03	16.15
Mixed sucker (2)	0.79	-----	-----
Irondale			
Smallmouth bass	0.01	<0.01	13.28
Flathead catfish	0.06	0.06	6.75
Redhorse sucker	0.02	0.01	9.32
Mixed sucker	0.07	-----	-----

NOTE: Means of two samples (individual fish) unless otherwise indicated. Reporting unit is ug/l wet weight.

Source: National Fisheries Research Laboratory Report (Ref. 16).

SECTION 5: PHYSICAL SETTING

5.1 CLIMATOLOGY AND DEMOGRAPHY

St. Francois County is hot in summer, especially at low elevations, and moderately cool in winter, especially on mountains and high hills. Rainfall is fairly heavy and well distributed throughout the year. Snow falls nearly every winter, but snow cover lasts only a few days at a time.

In winter the average temperature is 35 degrees F, and the average daily minimum temperature is 24 degrees F. In summer the average temperature is 75 degrees F, and the daily average maximum is 88 degrees F.

Of the total annual precipitation, 23 inches, or 60 percent, usually falls in April through September. The heaviest 1-day rainfall during the period of record was 4.95 inches at Farmington on June 30, 1957. Thunderstorms occur on about 50 days each year occurring primarily in summer. Average seasonal snowfall is 12 inches.

The average relative humidity is about 60 percent. Humidity is higher at night and the average at dawn is 80 percent. The prevailing wind is from the south. Average windspeed is highest, 12 miles per hour, in March. The climate is classified as humid continental (Ref. 20).

The population of St. Francois County recorded in 1982 was 42,600. Farmington, Missouri is the county seat and has a population of 8,270. Desloge, located 2,500 feet southeast and 300 feet south of the site, has a population of 3,481 (Ref. 26).

5.2 TOPOGRAPHY AND DRAINAGE

The Big River Mine Tailings site lies on the eastern side of the Ozark Highland in St. Francois County, Missouri. The major physical features in the area are the St. Francois Mountains to the south, the

Farmington Plain to the east, and the dissected topography of the Salem Plateau located to the north (Ref. 20). The site is between these major features on the floodplain of the Big River. The basin topography of the site is a rounded hill which slopes on the east, north, and west sides toward the Big River. A contour map of the site is included as Appendix E.

The on-site drainage pattern is discussed extensively in Section 2.3. The site drains primarily into the Big River along the entire perimeter of the horse-shoe bend where the site abuts the river and forms the site boundary.

5.3 SOILS

Most of the site is characterized by Psamments soils. This unit consists of deep, nearly level to gently rolling, excessively drained, newly formed soil in tailings ponds. These soils are formed in crushed dolomitic material from lead mining. Permeability is rapid and surface runoff is slow to medium although most precipitation is absorbed into the surface. The available water capacity is low. The natural fertility is very unbalanced, and careful fertilization is required to make the soil suitable for any plant growth. The organic matter is also very low. Some areas have been seeded to grasses and legumes but results are poor. These soils are generally unsuitable for growing grasses, shrubs, and trees unless intensively managed.

The areas where natural vegetation occurs on site consist mainly of Caneyville silt loam except for a small area on the southwest portion of the site where Gasconade, flaggy, silty, clay loam occurs.

Canyville silt loam has 2 to 5 percent slopes and is moderately deep, well drained. This soil occurrs on convex ridgetops. The surface layer is a dark-brown silt loam about 5 inches thick with a subsoil of silty clay loam and silty clay about 30 inches thick. Permeability is moderately slow, and surface runoff is slow to medium. Available water capacity is low.

Gasconade flaggy, sitly, clay loam has 9 to 35 percent slopes, is excessively drained, and occurs on uneven side slopes. The surface layer is a very dark-brown flaggy, silty, clay loam about 8 inches thick. The subsoil is dark-brown very flaggy, silty, clay about 5 inches thick. Permeability is moderately slow, and surface runoff is rapid. Available water capacity is very low.

All of the soils on site are underlain by hard-bedded dolomite (Ref. 20).

5.4 STRATIGRAPHY

The Big River Mine Tailings site is underlain by Precambrian felsites and granites, which are overlain by rock units of the Upper Cambrian series (Ref. 21 and 22). Figure 6 depicts the general stratigraphy of the site vicinity.

The Upper Cambrian Series rock units consist of in ascending order; the Lamotte Formation; the Bonneterre Formation; and the Elvins Group, which contains the Davis and Derby-Doerun formations. The Elvins Group, and the Potasi and Eminence formations will not be considered in this report because they are topographically higher than the Big River Mine Tailings site (Ref. 21 and 22).

The Lamotte Formation is predominantly a quartzose sandstone that grades laterally in many places into arkose and conglomerate (Ref. 22). The formation is approximately 300 feet thick in the study area (Ref. 21). The Lamotte aquifer is a regional drinking water source (Ref. 23).

The Bonneterre Formation is typically a light-gray, medium to fine-grained, medium-bedded dolomite, although it consists of relatively pure limestone in some areas (Ref. 22). The formation is approximately 350 feet thick in the study area. This formation is the principal source for lead mining in the area that occurred in the late 19th and early to mid 20th centuries. The Bonneterre aquifer is also a regional drinking water source (Ref. 23).

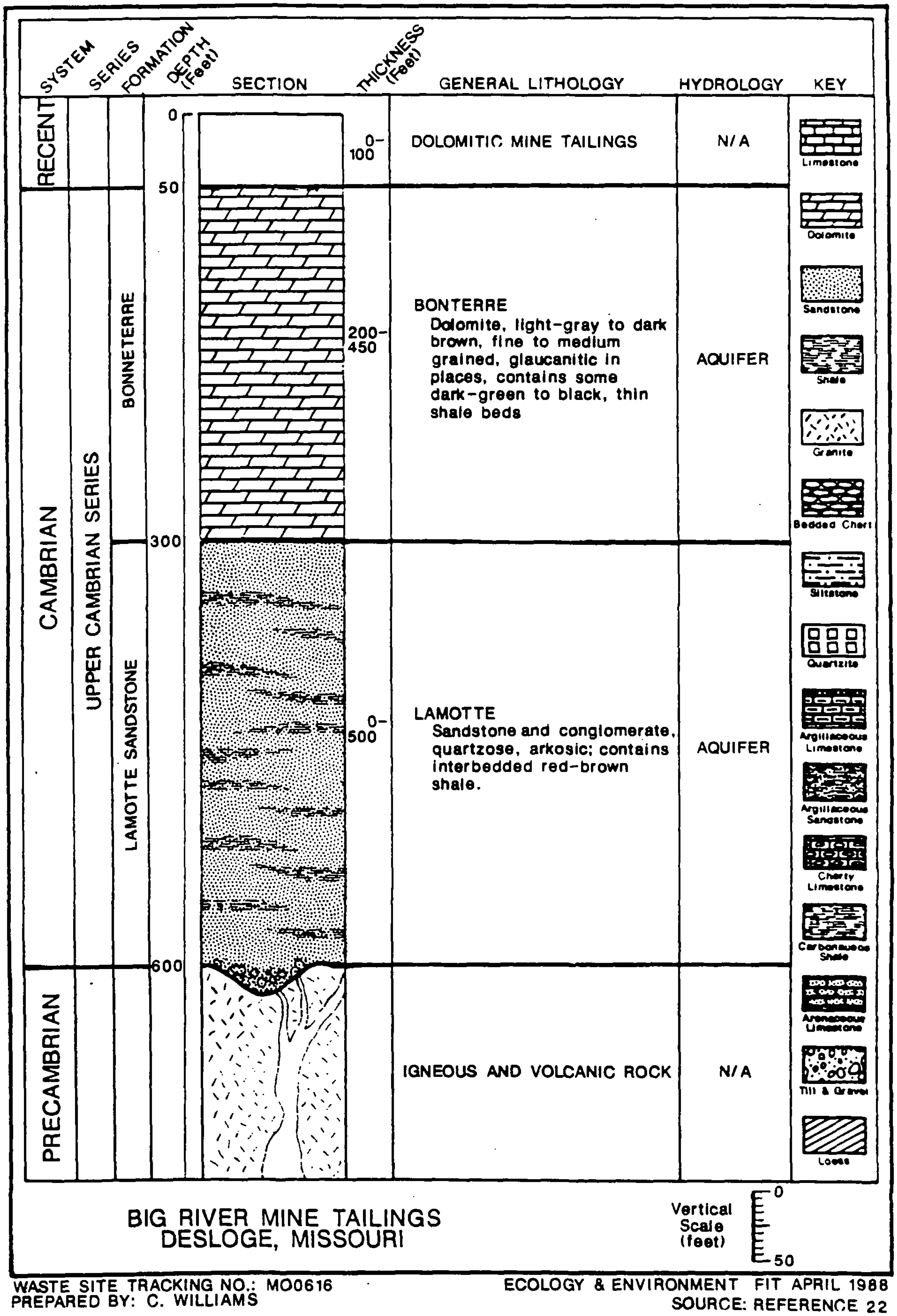

FIGURE 6: GENERALIZED STRATIGRAPHIC COLUMN

5.5 HYDROGEOLOGY

The area ground water aquifers that are topographically lower than the site are the Bonneterre and Lamotte Formations. The Flat River Water District serves the towns of Desloge, Elvin, Flat River, Leadington, River Mines, and Ester, Missouri. The approximate population served is 12,000 (Ref. 24). The Big River Mine Tailings site is adjacent to the town of Desloge and is within 2 miles of Flat River. The Flat River Water District's water supply comes from the Bonneterre Formation, via a sealed, abandoned mine shaft located approximately 2 miles south of the site in River Mines, Missouri; and from the Lamotte Formation, via a well located approximately 3,000 feet east in Desloge, Missouri, that is pumped from 410 feet (Ref. 24).

The typical ground water flow around the site is toward the river. Several natural springs around the site area flow into the Big River (Ref. 9). When the river is at flood stage, ground water may not flow toward the river, though this situation is unusual.

SECTION 6: SUMMARY AND CONCLUSIONS

In the spring of 1977 a catastrophic erosional event occurred in which a massive portion of the 600-acre Desloge Mine Tailings pile flowed into the Big River. As a result of this event, mine tailings laden with heavy metals were distributed several miles downstream. The tailings covered the benthic zone of the Big River and altered its physical and chemical composition. Because several other tailings piles exist in the area, it is difficult to attribute all of the heavy metal contamination in the Big River to the Desloge tailings pile. Certainly, the Desloge pile has been a major source of the tailings entering the Big River and has had a detrimental effect on the water quality in the river. It has been established through numerous research projects that lead concentrations are elevated in certain benthic-feeding biota at the Desloge tailings pile and for several miles downstream.

Some data has been collected to determine whether lead-bearing total suspended particulates are a concern at this site. Additional monitoring would be required to accurately characterize this element. The day of the FIT reconnaissance, strong winds had created a suspended particulate plume that originated at the site and was carried over the town of Desloge (Photos C-1, C-2, C-4).

The on-site county landfill has raised many concerns. The landfill operators apply a soil cap when filling is completed, which reduces wind erosion considerably. However, the potential for the release of lead to ground water and surface water (Big River) via acidic leachate from the landfill is high.

Remedial action by St. Joe Minerals Corp. has reduced water and wind erosion in certain areas. Yet the majority of the site remains extremely susceptible to wind erosion and water erosion is a severe, chronic problem in other areas.

Stabilization efforts have been undertaken by several agencies. Since 1985 St. Joe Minerals, the county landfill, and the Desloge Tailings Task Force all have made a concerted effort to provide adequate supervision and maintenance of the Desloge tailings pile, and have investigated possibilities for long-term stabilization of the site.

The Big River Mine Tailings site near Desloge, Missouri, is a documented source of chemical contamination. Additionally, erosional events have altered the benthic zone of the Big River. The site area is huge, covering approximately 600 acres. Though stabilization efforts have achieved some success, much more work is needed to minimize the erosion which now adversely influences the Big River and the local ambient air.

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